AD-A104 766 ARMY ENGINEER DISTRICT ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LIGUORI LAKE DAM (NO NAME 259) (MO--ETC(U)
SEP 78 A L JOHNSON

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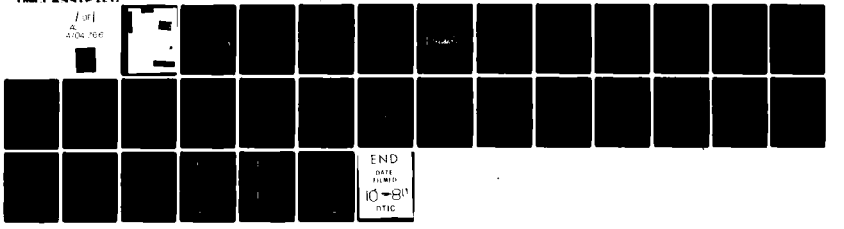

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A104 766 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Liguori Lake Dam - NONAME 255 (MO 30445) Jefferson County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report. / 6. PERFORMING ORG. REPORT NUMBER
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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Phase I Report
National Dam Safety Program

NAME: Liguori (Previously identified as Mo No Name 255)

LOCATION: Jefferson County, Missouri

STREAM: Unnamed Tributary of Glaize Creek

DATE OF INSPECTION: 28 August 1978

Liguori Dam (Mo. 30445) was inspected using the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, U.S. Army, Washington D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The downstream damage zone is approximately 2 miles long. Over 10 structures and two improved road crossings would be subjected to flooding with possible damage and/or destruction and possible loss of life. Interstate Highway 55 would also be subjected to possible damage. The dam is in the small size classification because it is less than 40 feet high and impounds less than 1000 acre-feet of water.

In accordance with the inspection guidelines, a dam of this classification, namely small size classification and high hazard potential classification, must have a spillway capable of passing 50 percent of the Probable Maximum Flood (PMF) without overtopping the dam. Since the spillway of this dam will pass only 25 percent of the PMF without overtopping the dam, and since overtopping of the dam could cause breeching due to erosion it is classified as an unsafe non-emergency structure. Also, our evaluation indicates that the spillway will not pass the 100-year flood, that is a flood having a 1 percent chance of exceedence in any given year.

The inspection team observed trees and brush growing in the dam. These root systems are a potential seepage hazard. One rodent hole was observed and the potential exists for additional such holes to be located after the trees and brush have been removed. A suitable turf should be established after the trees and brush have been removed and rodent holes filled.

i

The spillway area immediately downstream of the paved overflow section does not appear sufficiently resistant to prevent embankment erosion at high flows for an indefinite time. Seepage and stability analyses are not on record as recommended in the guidelines which is considered a deficiency which should be reconciled. The valve on the 4-inch pipe through the dam is not operable and should be repaired/replaced.

It is recommended that action be taken by the owner to correct the deficiencies listed herein in the near future. Corrective works should be in accordance with analyses and design performed by an engineer experienced in the design of dams. These conclusions were reached by the undersigned inspection team members.

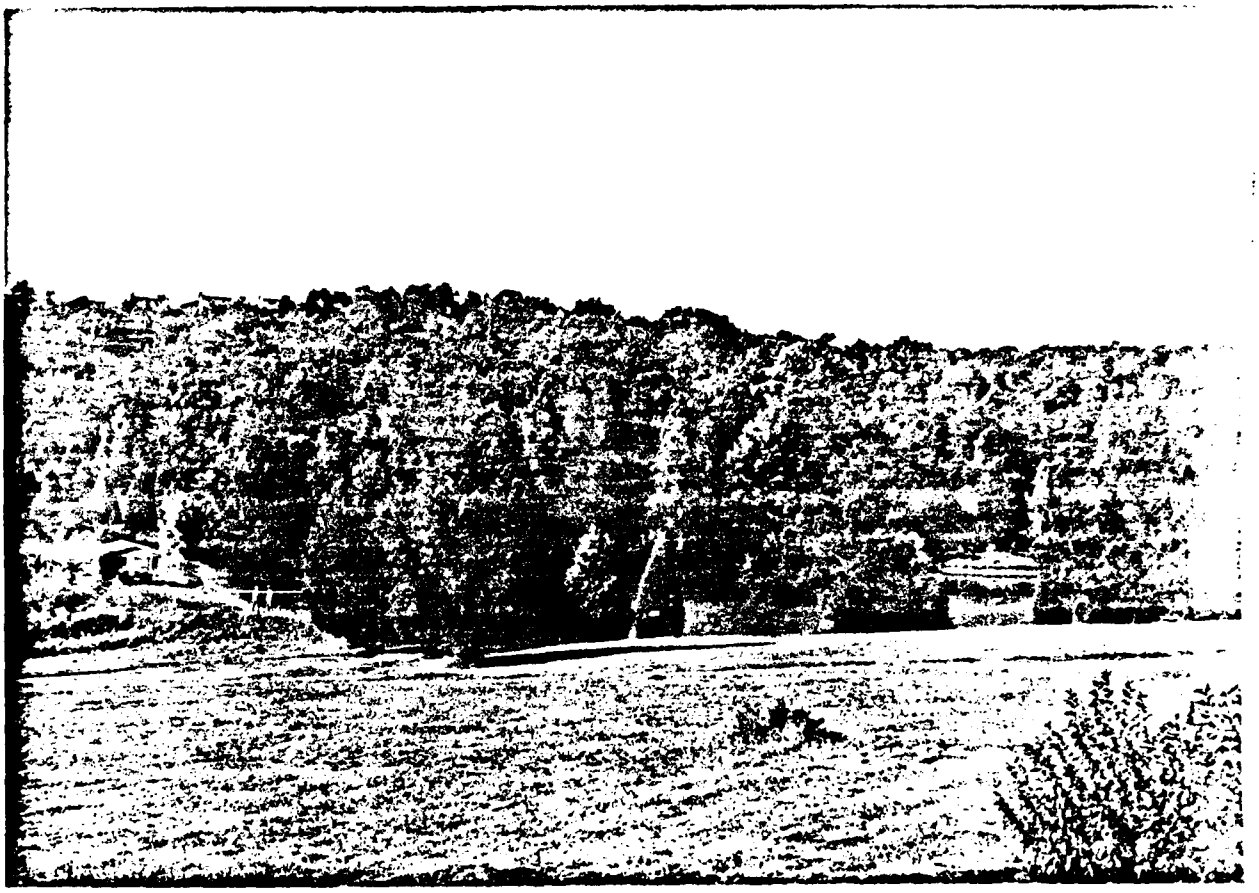
Thomas F. Wolff
THOMAS F. WOLFF
Soils Engineer

Lynne E. Puetz
LYNNE PUETZ
Hydraulic Engineer

Chien H. Hsieh
CHIEN H. HSIEH
Hydraulic Engineer

SUBMITTED BY: Arthur L. Johnson 20 Sep 78
for Chief, Engineering Division Date

APPROVED BY: Leon E. McKee 21 Sep '78
Colonel, CE, District Engineer Date



OVERVIEW OF LIGUORI DAM AND LAKE

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LIGUORI DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LIGUORI DAM ID NO. 30445

Section 1 - Project Information

1.1 GENERAL.

a. Authority: The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Liguori Dam be made.

b. Purpose of Inspection: The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria: The inspection was accomplished using the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, U.S. Army, Washington D.C., with the help of several Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

1.2 DESCRIPTION OF PROJECT.

a. Description of Dam and Appurtenances: The dam is an earth fill dam with a small concrete spillway in the right abutment. There is a 4-inch cast-iron outlet pipe through the base.

b. Location: Section 25, Township 42 North, Range 5 East

c. Size Classification: Small

d. Hazard Classification: High

e. Ownership: Redemptorist Fathers
Rev. William Broker, Rector
Liguori Publications
Liguori, Missouri 63057

f. Purpose of Dam: Recreation

g. Design and Construction History: The dam was reportedly constructed 28 years ago (1950±) by Burn Construction Company of House Springs, Missouri, for the present owner. The dam was reportedly constructed using borrow material from the lake area placed in lifts and commpacted by tracking with a dozer and rubber-tired scraper. The dam has no known cutoff trench or grout curtain.

h. Normal Operating Procedure: No operating records exist. Outflow passes over the uncontrolled spillway.

1.3 PERTINENT DATA.

a. Drainage Area: 115 acres

b. Discharge at Damsite: Not known

Maximum known flood at damsite - 2 feet depth over spillway reported

Spillway capacity at maximum pool elevation - 550 cfs

c. Elevation (feet above m.s.l. from assumed benchmark shown on PLATE 3):

Top of dam - 500±

Flood control pool - 500±

Recreation pool - 496±

Streambed - 475±

Maximum tailwater - Not known

d. Reservoir:

Length of maximum pool - Approximately 700 feet

Length of recreation pool - Approximately 500 feet

e. Storage (Acre-feet):

Recreation pool - 28

Flood control pool - 35

Design surcharge - 0

Top of dam - 35

f. Reservoir Surface (Acres):

Top of dam - 3.2

Maximum pool - 3.2

Flood control pool - 3.2

Recreation pool - 2.9

Spillway crest - 2.9

g. Dam:

Type - Earth fill

Length - 364 feet

Height - 25± feet

Top width - 40 feet

Side Slopes - Varies, typically 1 vertical on 2.0 horizontal downstream; upstream side slope could not be determined. A typical section is shown on PLATE 4.

Zoning - Not known

Impervious Core - Unknown. Dam is apparently constructed of relatively impervious sandy brown clays.

Cutoff - Unknown.

Grout curtain - Unknown

h. Diversion and Regulating Tunnel: None

i. Spillway:

Type - Earth/concrete channel (18-foot wide spillway)

Length of weir - Not applicable

Crest elevation - 496.7

Gates - None

j. Regulating Outlets: None (The existence of a 4-inch pipe through the dam is noted in paragraph 1.2a above; however, it was not considered since the valve is rusted in the closed position and the pipe is possibly filled with silt.)

Section 2 - Engineering Data

2.1 DESIGN. No design drawings or computations exist.

2.2 CONSTRUCTION. The dam was reportedly constructed 28 years ago (1950+) by Burns Construction Company of House Springs, Missouri, for the present owner. The dam was reportedly constructed using borrow material from the lake area placed in lifts and compacted by tracking with a dozer and a rubber-tired scraper. The dam has no known cutoff trench or grout curtain.

2.3 OPERATION. No operating records exist. Outflow passes over the uncontrolled spillway.

2.4 EVALUATION.

a. Availability: The only available engineering data is the personal recollections of Reverend Joseph Maier and Mr. John Meyer.

b. Adequacy: The field surveys and visual inspections presented herein are considered adequate to support the conclusions of this report.

c. Validity: Not applicable.

Section 3 - Visual Inspection

3.1 FINDINGS.

a. General: A representative of the owning monastery's maintenance staff accompanied the inspection team. The lake is used for recreational purposes by the monastery. A small frame bathhouse is located on the dam crown.

b. Project Geology: The reservoir area is characterized by brown, sandy, gravelly, residual clays formed on Ordovician or Mississippian sedimentary rocks.

c. Dam: The embankment is composed of brown sandy clay. No detrimental settlement, depressions, cracking, sinkholes, or slides were observed in or near the embankment.

Typical embankment slopes are shown on PLATE 4. The crown is relatively wide and gradually rounds into the upstream slope.

Heavy brush and trees were evident on the south half of the downstream slope. The owner's representative indicated that the dam had been well maintained until recent years and that the area was allowed to grow over to discourage neighboring children from trespassing. One animal burrow was found in the brush and a number of other burrows are likely to be present.

No significant erosion was noted.

No seepage was noted in or near the dam or its abutments.

A layer of hand-placed flagstone was placed on the upstream face of the dam at the water line. No benching or wave erosion was noted on the upstream slope.

d. Appurtenant Structures: A spillway, consisting of a small channel which is paved at the dam crest, is located at the right abutment. The outlet channel is earth and is grown over with brush and small trees. A willow tree is growing in the inlet channel just upstream of the spillway. The dam embankment just above the spillway and part of the inlet channel have been partially covered with unformed concrete. A small hole and underlying void was noted in the inlet channel paving.

A 4-inch cast-iron outlet pipe is located under the dam. A concrete block gatebox with lid containing a wheel operated gate valve is present at the downstream toe. The valve was frozen with rust and had not been operated for several years. The owner's representative indicated that the valve was periodically test-

operated in previous years but had not been operated recently. The pipe and valve were covered with surface rust but significant loss of metal thickness was not apparent.

e. Reservoir Area: A small dam, approximately 20 feet high, carrying a subdivision road is under construction a few hundred feet above the lake and off of the property. The dam is being constructed of end-dumped, uncompacted, unprotected fill which is eroding and silting the lake discussed herein. A failure of the upstream dam during its construction last year and subsequent erosion have reportedly deposited four or five feet of silt in the upper end of the lake.

f. Downstream Channel: An earth channel is provided to pass spillway flow. The channel is overgrown with brush and small trees.

3.2 EVALUATION. Trees and brush on the downstream slope are a potential seepage hazard and should be removed. The trees and brush also provide animal habitat and encourage burrows. Any burrows found after clearing the embankment should be filled.

Provision of graded riprap on the upstream face of the dam is considered good engineering practice; however, the small fetch (distance of lake over which a wave can develop), hilly terrain surrounding the lake, gentle upstream slope, and absence of existing wave erosion indicate the lack of riprap at this location is not of serious concern.

The apparent inoperability of the downstream gate valve should be corrected. The location of the valve on the downstream side is a potential problem since a failure of the pipe in the dam would introduce full pressure of the pool into the embankment and could initiate seepage, erosion, and instability. The embankment adjacent to the pipe should be inspected frequently for evidence of leakage.

Erosion protection of the embankment adjacent to the spillway and the spillway outlet channel appears insufficient to resist sustained high flows.

Erosion and the threat of possible failure of the small subdivison dam upstream could adversely affect the lake discussed herein by silting, which would reduce storage and possibly contribute to overtopping.

Section 4 - Operational Procedures

4.1 PROCEDURES. Operational procedures are essentially nonexistent since the dam has an uncontrolled spillway and water passes freely over the spillway.

4.2 MAINTENANCE OF DAM. Little recent maintenance is apparent as evidenced by the vegetative cover, animal burrows, and brush and small trees growing near the spillway. An exception is the dam crown and the north end of the embankment which are mowed.

4.3 MAINTENANCE OF OPERATING FACILITIES. The only operational feature of this dam is the gate valve on the downstream end of the 4-inch cast-iron pipe through the embankment. This valve has not been operated for several years and should receive routine maintenance to assure operability.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT. No warning system is known to exist.

4.5 EVALUATION. Additional maintenance in the form of clearing and mowing the embankments, filling burrows, and establishing turf is recommended. The outlet valve should be made operable and periodically operated.

Section 5 - Hydraulic/Hydrologic

5.1 EVALUATION OF FEATURES.

a. Design Data: No design data were made available to the inspection team.

b. Experience Data: All of the pertinent data furnished in this report were derived from U.S. Geological Survey 7-1/2 minute quadrangle sheets or from measurements and surveys made during the inspection.

c. Visual Observations:

(1) A valve-controlled 4-inch diameter pipe through the dam has been used to regulate releases. However, this valve has not been opened in several years and appears to be rusted closed. As a result, this pipe would not be effective in releasing flow.

(2) The spillway consists of a channel with a parallel guide levee at the right side of the dam and continuing downstream through a natural valley. This channel is paved at the crest of the dam for about 15 feet and is natural earth downstream.

d. Overtopping Potential: The spillway cannot pass the Probable Maximum Flood (PMF) nor one half the PMF without overtopping the dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydraulic conditions that are reasonably possible in the region. The spillway will pass 25 percent of the PMF without overtopping. Routing the PMF through the reservoir reveals that the dam would be overtopped for approximately 1 hour; depth of overtopping would be approximately 1.2 feet and the discharge approximately 1300 cfs.

The effects from rupture of the dam could extend approximately 2 miles downstream of the dam. There are 3 improved road crossings, including the I-55 crossing, and 10 inhabited homes downstream of the dam which could be severely damaged and lives of inhabitants could be lost should failure of the dam occur.

Section 6 - Structural Stability

6.1 EVALUATION OF STRUCTURAL STABILITY.

a. Visual Observations: Visual observations of the dam and spillway are discussed and evaluated in Section 3 and 5. The dam has no other appurtenant structures.

b. Design and Construction Data: As discussed in Section 2, no significant design data are available. No stability analyses or seepage analyses have been performed. Construction data is based on the personal recollections of the individuals mentioned in Section 2.

c. Operating Records: No operating records are available.

d. Post Construction Changes: According to the owner, no post-construction changes have occurred.

e. Seismic Stability: The dam is located in Seismic Zone 2, for which the inspection guidelines assign a "moderate" damage probability and design seismic coefficient of 0.05 g. Since neither original design analyses nor strengths of construction materials are available, an accurate seismic analysis cannot be made. The low dam height and clayey materials in the dam are factors minimizing the likelihood of failure due to an earthquake.

Section 7 - Assessment/Remedial Measures

7.1 DAM ASSESSMENT.

a. Safety: Several items are deficient which should be corrected. These items are vegetative cover, animal burrows, inoperability of the outlet valve, insufficient erosion protection for the spillway, and insufficient spillway capacity.

b. Adequacy of Information: No details are available regarding design of the dam. Data from the visual observations and verbal discussions are considered adequate to support the conclusions herein.

c. Urgency: It is recommended that the remedial measures listed in Section 7.2 be accomplished in the near future.

d. Necessity for Phase II: No Phase II inspection is recommended. The recommended remedial actions can be accomplished without further investigation.

7.2 REMEDIAL MEASURES.

The following remedial measures are recommended:

a. Remove trees and brush.

b. Fill animal burrows.

c. Establish and maintain a grass cover on the embankment where absent after clearing.

d. Spillway size and/or height of dam should be increased to pass the probable maximum flood. In either case, the spillway should be protected to prevent erosion.

e. Replace or restore the outlet valve to an operable condition and maintain it thereafter.

f. Perform seepage and stability analyses.

g. The dam should be periodically inspected by an engineer experienced in the design and construction of earth dams. Records from these inspections and maintenance operations should be kept by the owner.

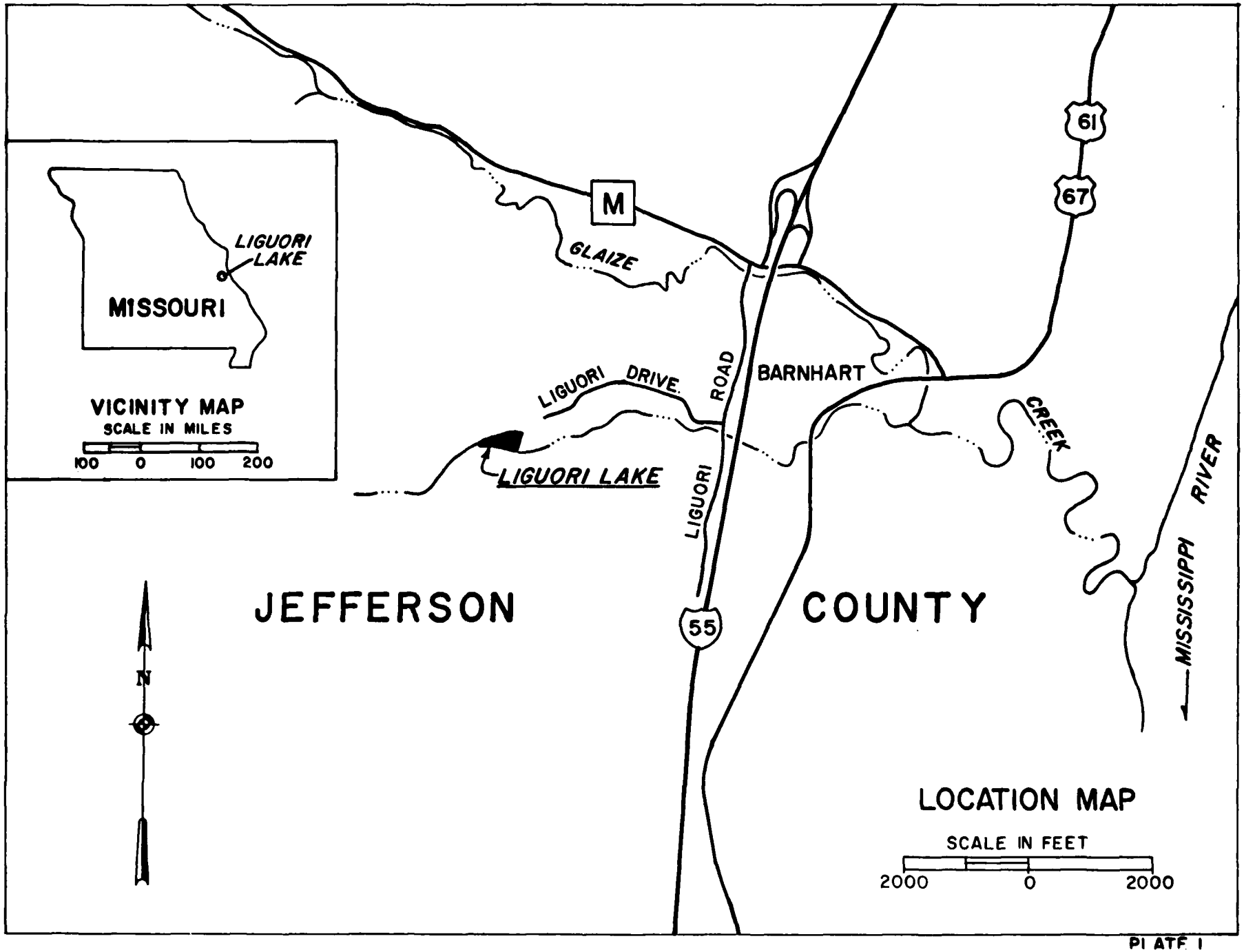
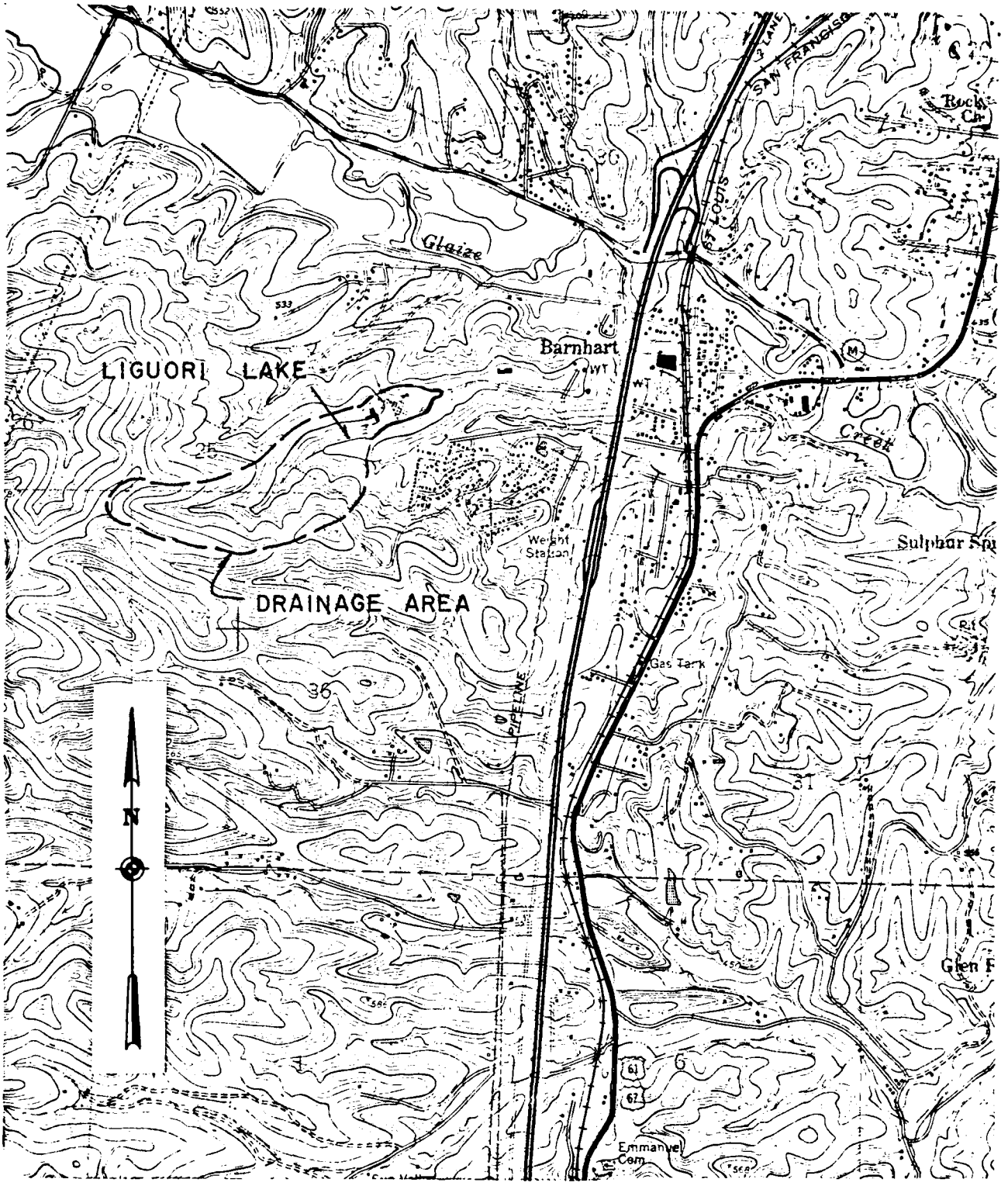

LIGUORI LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
M
GLAIZE
61
67
BARNHART
LIGUORI DRIVE
ROAD
LIGUORI
CREEK
MISSISSIPPI RIVER
LIGUORI LAKE
55
JEFFERSON
COUNTY
N
LOCATION MAP
SCALE IN FEET
2000 0 2000

PLATE 1



SCALE IN FEET

2000 1000 0 2000 4000

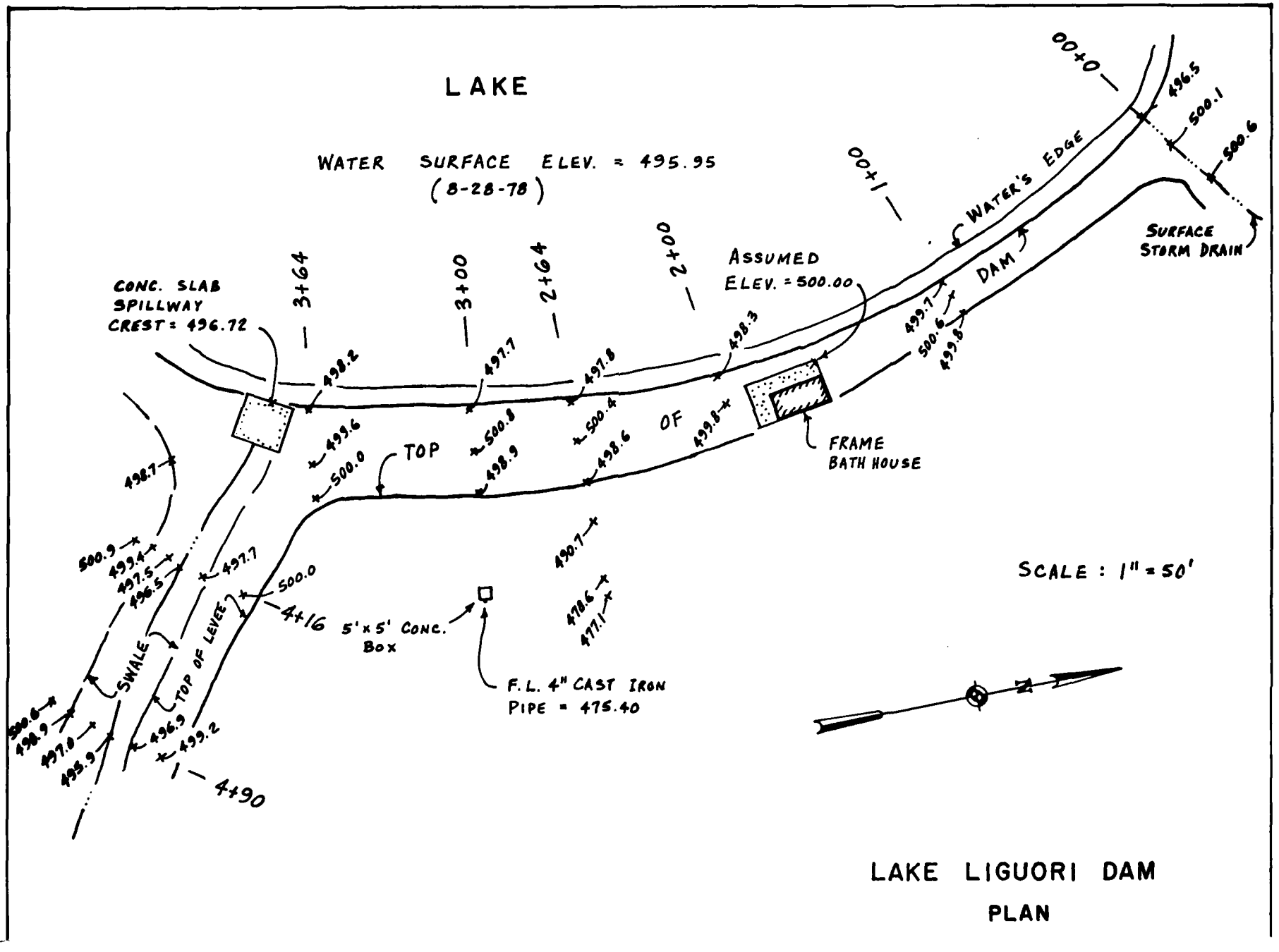
1000 500 0 1000

SCALE IN METERS

LIGUORI LAKE

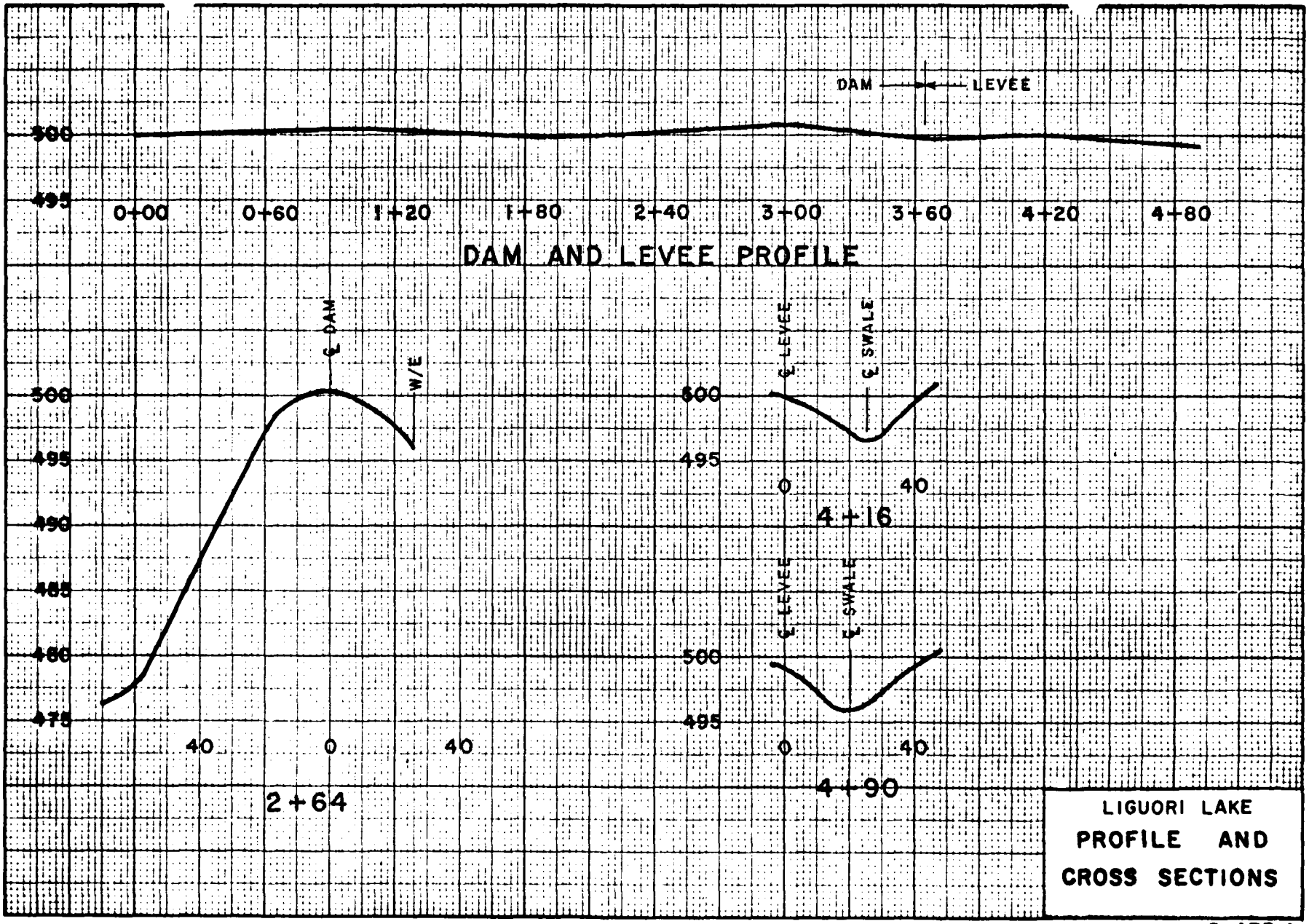
VICINITY TOPOGRAPHY

PLATE 2



LAKE LIGUORI DAM

PLAN



LIGUORI LAKE

PROFILE AND CROSS SECTIONS

PLATE 4

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with total depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

PROJECT		COMPUTED BY	DATE
DAM SAFETY INSPECTION	Page 1 of —		
SUBJECT		CHECKED BY	DATE
LIGJURI DAM			

BACKGROUND INFORMATION

BUILT about 1950
SPILLWAY IS A CHANNEL @ SIDE OF DAM
DAM HAS NOT BEEN OVERTOPPED
WHEN U.S DAM BREACHED, SPILLWAY HAD ABOUT 2-3' OF WATER IN IT - DAM DID NOT OVERTOP
U.S. DAM BREACHED IN 1977, CAUSED SILTATION IN LAKE
4-5' SILT IN UPPER END.

BASIC DATA

DA = 115 acres = .18 mi^2

TC = 20 hr = 12 MIN
(USING KIRPICH EQ.)

TOP OF DAM = 504.8

SPILLWAY CREST = 501.7

ANTECEDENT CONDITION III

SCS CURVE NO 91

STORAGE - ELEVATION

(AC-FT)	(FT MSL)
0	483
35	505
56	510
130	520
236	530
368	540

SPILLWAY RATING CURVE
CALCULATED USING
NORMAL DEPTH EQUATIONS.

ELEVATIONS SHOWN HERE WERE DERIVED FROM THE FIELD SURVEYS AND THE STORAGE SHOWN IN THE 1973 DAM INVENTORY. USING THE STORAGE SHOWN @ TOP OF DAM FROM THE INVENTORY AND STORAGE - ELEVATION CURVES FOR THE RESERVOIR GAVE A TOP OF DAM ELEV. OF 504.8.

```
      1              A1       LIGUORI LAKE DAM  JEFFERSON COUNTY,MO
      2              A2       DAM SAFETY ANALYSIS  INVENTORY NO 30445
      3              A3       LYNNE PUETZ SEPT 1978
      4              R    288       0       5       0       0       0       0       0      -5       0
      5              B1     5
      6              J      1       8       1
      7              J1   .20     .25     .30     .35     .40     .45     .50    1.0
      8              K      0       1                               3       1
      9              K1 **** INFLOW HYDROGRAPH ****
     10              M      1       2    0.18                       1.0                    1
     11              P      0      25     102     120     130
     12              T                                                      -1      -91
     13              M2             .12
     14              X     -.5    -.02     1.5
     15              K      1   30445                                       1
     16              K1 **** RESERVOIR ROUTING BY MODIFIED PULS ****
     17              Y                                       1       1
     18              Y1    -1                                                501.7      -1
     19              Y4 501.7     503     504     505     506     507
     20              Y5     0      55     215     550    1075    1800
     21              SS     0      18      28      35      56      82     125
     22              SE   483     498   501.7   504.8     510     515     520
     23              SS 501.7
     24              SD 504.8     2.7     1.5     364
     25              K     99
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                   RUNOFF HYDROGRAPH AT          1
                                   ROUTE HYDROGRAPH TO       30445
                                   END OF NETWORK
```

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.21	.21	.01	125.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.21	.21	.00	204.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.21	.21	.00	254.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.21	.21	.00	274.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.21	.21	.00	284.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.21	.21	.00	288.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.21	.21	.00	290.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.21	.21	.00	291.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.21	.21	.00	291.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.21	.21	.00	291.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.21	.21	.00	292.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.21	.21	.00	292.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.25	.00	304.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.26	.25	.00	326.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.26	.25	.00	341.
1.01	1.20	16	.01	.00	.01	0.	1.01	13.20	160	.26	.25	.00	347.
1.01	1.25	17	.01	.00	.01	1.	1.01	13.25	161	.26	.25	.00	350.
1.01	1.30	18	.01	.00	.01	1.	1.01	13.30	162	.26	.25	.00	351.
1.01	1.35	19	.01	.00	.01	1.	1.01	13.35	163	.26	.25	.00	352.
1.01	1.40	20	.01	.00	.01	2.	1.01	13.40	164	.26	.25	.00	352.
1.01	1.45	21	.01	.00	.01	2.	1.01	13.45	165	.26	.25	.00	352.
1.01	1.50	22	.01	.00	.01	3.	1.01	13.50	166	.26	.25	.00	352.
1.01	1.55	23	.01	.00	.01	3.	1.01	13.55	167	.26	.25	.00	352.
1.01	2.00	24	.01	.00	.01	4.	1.01	14.00	168	.26	.25	.00	353.
1.01	2.05	25	.01	.00	.01	4.	1.01	14.05	169	.32	.32	.00	370.
1.01	2.10	26	.01	.00	.01	4.	1.01	14.10	170	.32	.32	.00	404.
1.01	2.15	27	.01	.00	.01	5.	1.01	14.15	171	.32	.32	.00	426.
1.01	2.20	28	.01	.00	.01	5.	1.01	14.20	172	.32	.32	.00	435.
1.01	2.25	29	.01	.00	.01	5.	1.01	14.25	173	.32	.32	.00	439.
1.01	2.30	30	.01	.00	.01	6.	1.01	14.30	174	.32	.32	.00	440.
1.01	2.35	31	.01	.00	.01	6.	1.01	14.35	175	.32	.32	.00	441.
1.01	2.40	32	.01	.00	.01	6.	1.01	14.40	176	.32	.32	.00	442.
1.01	2.45	33	.01	.01	.01	7.	1.01	14.45	177	.32	.32	.00	442.
1.01	2.50	34	.01	.01	.01	7.	1.01	14.50	178	.32	.32	.00	442.
1.01	2.55	35	.01	.01	.01	7.	1.01	14.55	179	.32	.32	.00	442.
1.01	3.00	36	.01	.01	.01	7.	1.01	15.00	180	.32	.32	.00	442.
1.01	3.05	37	.01	.01	.01	8.	1.01	15.05	181	.19	.19	.00	409.
1.01	3.10	38	.01	.01	.01	8.	1.01	15.10	182	.39	.39	.00	394.
1.01	3.15	39	.01	.01	.01	8.	1.01	15.15	183	.39	.39	.00	456.
1.01	3.20	40	.01	.01	.01	8.	1.01	15.20	184	.58	.58	.00	556.
1.01	3.25	41	.01	.01	.01	9.	1.01	15.25	185	.68	.68	.00	706.
1.01	3.30	42	.01	.01	.01	9.	1.01	15.30	186	1.65	1.64	.00	1094.
1.01	3.35	43	.01	.01	.01	9.	1.01	15.35	187	2.71	2.71	.01	1967.
1.01	3.40	44	.01	.01	.01	9.	1.01	15.40	188	1.07	1.06	.00	2451.
1.01	3.45	45	.01	.01	.01	10.	1.01	15.45	189	.68	.68	.00	1965.
1.01	3.50	46	.01	.01	.01	10.	1.01	15.50	190	.58	.58	.00	1386.
1.01	3.55	47	.01	.01	.01	10.	1.01	15.55	191	.39	.39	.00	1013.
1.01	4.00	48	.01	.01	.01	10.	1.01	16.00	192	.39	.39	.00	762.
1.01	4.05	49	.01	.01	.01	10.	1.01	16.05	193	.30	.30	.00	610.
1.01	4.10	50	.01	.01	.01	10.	1.01	16.10	194	.30	.30	.00	508.
1.01	4.15	51	.01	.01	.01	11.	1.01	16.15	195	.30	.30	.00	452.
1.01	4.20	52	.01	.01	.01	11.	1.01	16.20	196	.30	.30	.00	428.
1.01	4.25	53	.01	.01	.01	11.	1.01	16.25	197	.30	.30	.00	419.
1.01	4.30	54	.01	.01	.01	11.	1.01	16.30	198	.30	.30	.00	416.
1.01	4.35	55	.01	.01	.01	11.	1.01	16.35	199	.30	.30	.00	415.
1.01	4.40	56	.01	.01	.01	11.	1.01	16.40	200	.30	.30	.00	414.

1.01	4.55	55	.01	.01	.01	11.	1.01	16.55	199	.30	.30	.00	415.
1.01	4.	56	.01	.01	.01	11.	1.01	16.40	200	.30	.30	.00	414.
1.01	4.	57	.01	.01	.01	12.	1.01	16.45	201	.30	.30	.00	414.
1.01	4.50	58	.01	.01	.01	12.	1.01	16.50	202	.30	.30	.00	414.
1.01	4.55	59	.01	.01	.01	12.	1.01	16.55	203	.30	.30	.00	414.
1.01	5.00	60	.01	.01	.01	12.	1.01	17.00	204	.30	.30	.00	414.
1.01	5.05	61	.01	.01	.01	12.	1.01	17.05	205	.23	.23	.00	397.
1.01	5.10	62	.01	.01	.01	12.	1.01	17.10	206	.23	.23	.00	362.
1.01	5.15	63	.01	.01	.00	12.	1.01	17.15	207	.23	.23	.00	341.
1.01	5.20	64	.01	.01	.00	12.	1.01	17.20	208	.23	.23	.00	332.
1.01	5.25	65	.01	.01	.00	13.	1.01	17.25	209	.23	.23	.00	328.
1.01	5.30	66	.01	.01	.00	13.	1.01	17.30	210	.23	.23	.00	326.
1.01	5.35	67	.01	.01	.00	13.	1.01	17.35	211	.23	.23	.00	326.
1.01	5.40	68	.01	.01	.00	13.	1.01	17.40	212	.23	.23	.00	325.
1.01	5.45	69	.01	.01	.00	13.	1.01	17.45	213	.23	.23	.00	325.
1.01	5.50	70	.01	.01	.00	13.	1.01	17.50	214	.23	.23	.00	325.
1.01	5.55	71	.01	.01	.00	13.	1.01	17.55	215	.23	.23	.00	325.
1.01	6.00	72	.01	.01	.00	13.	1.01	18.00	216	.23	.23	.00	325.
1.01	6.05	73	.06	.04	.02	23.	1.01	18.05	217	.02	.02	.00	268.
1.01	6.10	74	.06	.05	.02	42.	1.01	18.10	218	.02	.02	.00	153.
1.01	6.15	75	.06	.05	.02	54.	1.01	18.15	219	.02	.02	.00	81.
1.01	6.20	76	.06	.05	.02	60.	1.01	18.20	220	.02	.02	.00	51.
1.01	6.25	77	.06	.05	.01	64.	1.01	18.25	221	.02	.02	.00	47.
1.01	6.30	78	.06	.05	.01	66.	1.01	18.30	222	.02	.02	.00	46.
1.01	6.35	79	.06	.05	.01	67.	1.01	18.35	223	.02	.02	.00	44.
1.01	6.40	80	.06	.05	.01	69.	1.01	18.40	224	.02	.02	.00	42.
1.01	6.45	81	.06	.05	.01	70.	1.01	18.45	225	.02	.02	.00	40.
1.01	6.50	82	.06	.05	.01	71.	1.01	18.50	226	.02	.02	.00	39.
1.01	6.55	83	.06	.05	.01	72.	1.01	18.55	227	.02	.02	.00	37.
1.01	7.00	84	.06	.05	.01	72.	1.01	19.00	228	.02	.02	.00	36.
1.01	7.05	85	.06	.05	.01	73.	1.01	19.05	229	.02	.02	.00	34.
1.01	7.10	86	.06	.05	.01	74.	1.01	19.10	230	.02	.02	.00	33.
1.01	7.15	87	.06	.05	.01	74.	1.01	19.15	231	.02	.02	.00	32.
1.01	7.20	88	.06	.05	.01	75.	1.01	19.20	232	.02	.02	.00	30.
1.01	7.25	89	.06	.05	.01	76.	1.01	19.25	233	.02	.02	.00	29.
1.01	7.30	90	.06	.06	.01	76.	1.01	19.30	234	.02	.02	.00	29.
1.01	7.35	91	.06	.06	.01	77.	1.01	19.35	235	.02	.02	.00	29.
1.01	7.40	92	.06	.06	.01	77.	1.01	19.40	236	.02	.02	.00	29.
1.01	7.45	93	.06	.06	.01	77.	1.01	19.45	237	.02	.02	.00	29.
1.01	7.50	94	.06	.06	.01	78.	1.01	19.50	238	.02	.02	.00	29.
1.01	7.55	95	.06	.06	.01	78.	1.01	19.55	239	.02	.02	.00	29.
1.01	8.00	96	.06	.06	.01	79.	1.01	20.00	240	.02	.02	.00	29.
1.01	8.05	97	.06	.06	.01	79.	1.01	20.05	241	.02	.02	.00	29.
1.01	8.10	98	.06	.06	.01	79.	1.01	20.10	242	.02	.02	.00	29.
1.01	8.15	99	.06	.06	.01	79.	1.01	20.15	243	.02	.02	.00	29.
1.01	8.20	100	.06	.06	.00	80.	1.01	20.20	244	.02	.02	.00	29.
1.01	8.25	101	.06	.06	.00	80.	1.01	20.25	245	.02	.02	.00	29.
1.01	8.30	102	.06	.06	.00	80.	1.01	20.30	246	.02	.02	.00	29.
1.01	8.35	103	.06	.06	.00	81.	1.01	20.35	247	.02	.02	.00	29.
1.01	8.40	104	.06	.06	.00	81.	1.01	20.40	248	.02	.02	.00	29.
1.01	8.45	105	.06	.06	.00	81.	1.01	20.45	249	.02	.02	.00	29.
1.01	8.50	106	.06	.06	.00	81.	1.01	20.50	250	.02	.02	.00	29.
1.01	8.55	107	.06	.06	.00	81.	1.01	20.55	251	.02	.02	.00	29.
1.01	9.00	108	.06	.06	.00	82.	1.01	21.00	252	.02	.02	.00	29.
1.01	9.05	109	.06	.06	.00	82.	1.01	21.05	253	.02	.02	.00	29.
1.01	9.10	110	.06	.06	.00	82.	1.01	21.10	254	.02	.02	.00	29.
1.01	9.15	111	.06	.06	.00	82.	1.01	21.15	255	.02	.02	.00	29.
1.01	9.20	112	.06	.06	.00	82.	1.01	21.20	256	.02	.02	.00	29.
1.01	9.25	113	.06	.06	.00	82.	1.01	21.25	257	.02	.02	.00	29.
1.01	9.30	114	.06	.06	.00	82.	1.01	21.30	258	.02	.02	.00	29.
1.01	9.35	115	.06	.06	.00	83.	1.01	21.35	259	.02	.02	.00	29.

1.01	8.20	100	.06	.06	.00	80.	1.01	20.20	244	.02	.02	.00	29.
1.01	8.25	101	.06	.06	.00	80.	1.01	20.25	245	.02	.02	.00	29.
1.01	8.30	102	.06	.06	.00	80.	1.01	20.30	246	.02	.02	.00	29.
1.01	8.35	103	.06	.06	.00	81.	1.01	20.35	247	.02	.02	.00	29.
1.01	8.40	104	.06	.06	.00	81.	1.01	20.40	248	.02	.02	.00	29.
1.01	8.45	105	.06	.06	.00	81.	1.01	20.45	249	.02	.02	.00	29.
1.01	8.50	106	.06	.06	.00	81.	1.01	20.50	250	.02	.02	.00	29.
1.01	8.55	107	.06	.06	.00	81.	1.01	20.55	251	.02	.02	.00	29.
1.01	9.00	108	.06	.06	.00	82.	1.01	21.00	252	.02	.02	.00	29.
1.01	9.05	109	.06	.06	.00	82.	1.01	21.05	253	.02	.02	.00	29.
1.01	9.10	110	.06	.06	.00	82.	1.01	21.10	254	.02	.02	.00	29.
1.01	9.15	111	.06	.06	.00	82.	1.01	21.15	255	.02	.02	.00	29.
1.01	9.20	112	.06	.06	.00	82.	1.01	21.20	256	.02	.02	.00	29.
1.01	9.25	113	.06	.06	.00	82.	1.01	21.25	257	.02	.02	.00	29.
1.01	9.30	114	.06	.06	.00	82.	1.01	21.30	258	.02	.02	.00	29.
1.01	9.35	115	.06	.06	.00	83.	1.01	21.35	259	.02	.02	.00	29.
1.01	9.40	116	.06	.06	.00	83.	1.01	21.40	260	.02	.02	.00	29.
1.01	9.45	117	.06	.06	.00	83.	1.01	21.45	261	.02	.02	.00	29.
1.01	9.50	118	.06	.06	.00	83.	1.01	21.50	262	.02	.02	.00	29.
1.01	9.55	119	.06	.06	.00	83.	1.01	21.55	263	.02	.02	.00	29.
1.01	10.00	120	.06	.06	.00	83.	1.01	22.00	264	.02	.02	.00	29.
1.01	10.05	121	.06	.06	.00	83.	1.01	22.05	265	.02	.02	.00	29.
1.01	10.10	122	.06	.06	.00	83.	1.01	22.10	266	.02	.02	.00	29.
1.01	10.15	123	.06	.06	.00	83.	1.01	22.15	267	.02	.02	.00	29.
1.01	10.20	124	.06	.06	.00	84.	1.01	22.20	268	.02	.02	.00	29.
1.01	10.25	125	.06	.06	.00	84.	1.01	22.25	269	.02	.02	.00	29.
1.01	10.30	126	.06	.06	.00	84.	1.01	22.30	270	.02	.02	.00	29.
1.01	10.35	127	.06	.06	.00	84.	1.01	22.35	271	.02	.02	.00	29.
1.01	10.40	128	.06	.06	.00	84.	1.01	22.40	272	.02	.02	.00	29.
1.01	10.45	129	.06	.06	.00	84.	1.01	22.45	273	.02	.02	.00	29.
1.01	10.50	130	.06	.06	.00	84.	1.01	22.50	274	.02	.02	.00	29.
1.01	10.55	131	.06	.06	.00	84.	1.01	22.55	275	.02	.02	.00	29.
1.01	11.00	132	.06	.06	.00	84.	1.01	23.00	276	.02	.02	.00	29.
1.01	11.05	133	.06	.06	.00	84.	1.01	23.05	277	.02	.02	.00	29.
1.01	11.10	134	.06	.06	.00	84.	1.01	23.10	278	.02	.02	.00	29.
1.01	11.15	135	.06	.06	.00	84.	1.01	23.15	279	.02	.02	.00	29.
1.01	11.20	136	.06	.06	.00	84.	1.01	23.20	280	.02	.02	.00	29.
1.01	11.25	137	.06	.06	.00	84.	1.01	23.25	281	.02	.02	.00	29.
1.01	11.30	138	.06	.06	.00	85.	1.01	23.30	282	.02	.02	.00	29.
1.01	11.35	139	.06	.06	.00	85.	1.01	23.35	283	.02	.02	.00	29.
1.01	11.40	140	.06	.06	.00	85.	1.01	23.40	284	.02	.02	.00	29.
1.01	11.45	141	.06	.06	.00	85.	1.01	23.45	285	.02	.02	.00	29.
1.01	11.50	142	.06	.06	.00	85.	1.01	23.50	286	.02	.02	.00	29.
1.01	11.55	143	.06	.06	.00	85.	1.01	23.55	287	.02	.02	.00	29.
1.01	12.00	144	.06	.06	.00	85.	1.02	0.00	288	.02	.02	.00	29.
									SUM	32.50	31.34	1.16	43722.
										(826.)	(796.)	(29.)	(1238.07)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .25	RATIO 3 .30	RATIO 4 .35	RATIO 5 .40	RATIO 6 .45	RATIO 7 .50	RATIO 8 1.00
HYDROGRAPH AT	1	.18	1	490.	613.	735.	858.	980.	1103.	1225.	2451.
		(.47)		(13.88)(	17.35)(	20.82)(	24.29)(	27.76)(	31.23)(	34.70)(	69.40)(
ROUTED TO	30445	.18	1	413.	523.	655.	776.	884.	1017.	1149.	2359.
		(.47)		(11.71)(	14.81)(	18.54)(	21.98)(	25.03)(	28.79)(	32.53)(	66.79)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	501.70	501.70	504.80
STORAGE	28.	28.	35.
OUTFLOW	0.	0.	483.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	504.59	0.00	35.	413.	0.00	15.75	0.00
.25	504.87	.07	35.	523.	.08	15.75	0.00
.30	505.01	.21	36.	655.	.25	15.75	0.00
.35	505.11	.31	36.	776.	.25	15.75	0.00
.40	505.19	.39	37.	884.	.42	15.75	0.00
.45	505.28	.48	37.	1017.	.42	15.67	0.00
.50	505.36	.56	37.	1149.	.42	15.67	0.00
1.00	506.00	1.20	40.	2359.	.92	15.67	0.00

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1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  29 AUG 78
 **********************************
EOI.
E>Q
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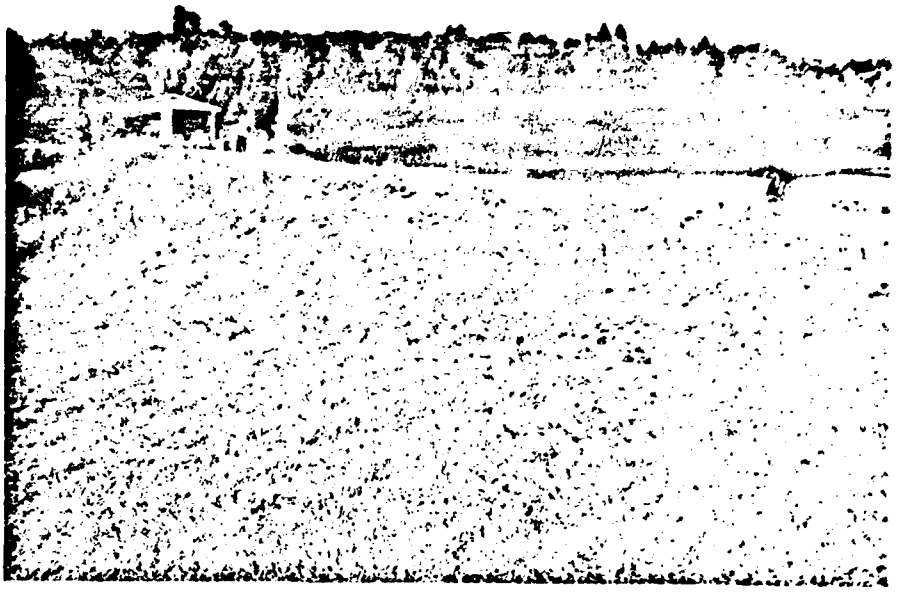


PHOTO 1 Downstream Face in vicinity of left abutment

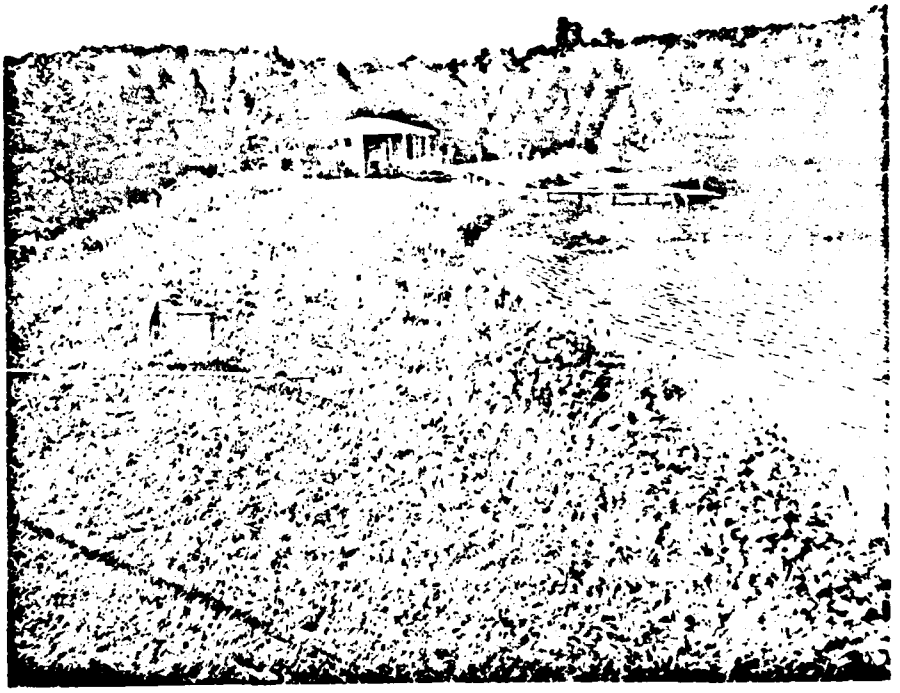


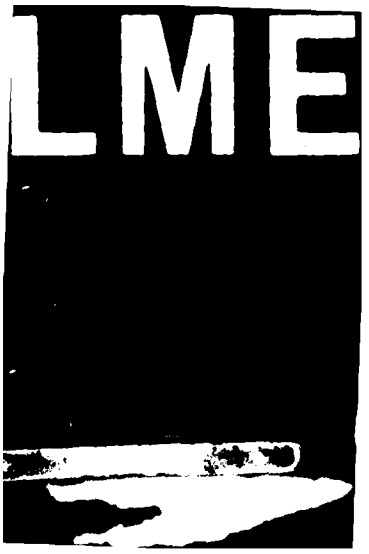
PHOTO 2 Dam crown and upstream face

PHOTO 3 Dam and spillway from right abutment

PHOTO 4 Spillway

PHOTO 5 Rodent hole in downstream slope

PHOTO 6 Valve and valve box on 4-inch cast iron pipe through dam


LME